ADDITIVE MANUFACTURING OF OXIDE DISPERSION STRENGTHENED (ODS) ALLOYS

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Oxide dispersion strengthened (ODS) alloys such as ODS Ni alloys or ODS steels offer an unmatched combination of deformation-, creep-, coarsening-, oxidation- and corrosion resistance. However, while these fundamental material properties are exceptionally well suited to power generation and engines, the manufacture of components using ODS alloys are currently subject to severe economic and technical barriers. Conventional wisdom is that powder metallurgy (PM) is the only available method to create ODS alloys from powders to which oxides were added via ball milling: if these composite powders are melted via traditional methods, their oxide dispersoids are lost via one or more of coarsening, dissolution, agglomeration into inter-dendritic space, and floating to the surface of the ingot (‘slagging”).

The low machinability of these highly-reinforced alloys motivates research in additive manufacturing as an alternative fabrication method, in particular via rapid melting and solidification. Therefore, there has been an increasing interest in the fabrication of ODS alloys via laser-based powder-bed fusion (L-PBF) or laser direct metal deposition (DMD) in the recent years.

This presentation summarizes the research activities in the field of AM of ODS alloys performed at Empa and Northwestern University over the last ~10 years. During this time, a variety of different solid-solution strengthened and precipitation strengthened γ-TiAl and Ti alloys, Ni alloys, Al alloys as well as steels were reinforced with nanometric oxides (Y_2O_3, HfO_2, Al_2O_3) and successfully fabricated by L-PBF and DMD. The main findings with regard to microstructure formation during AM, microstructure stability during heat treatments as well as the mechanical performance at elevated temperature of some selected ODS alloys will be presented and the main 'lessons learned' with regard to the AM fabrication of such alloy will be discussed.